## II. "Abstract of the Results of the Comparisons of the Standards of Length of England, France, Belgium, Prussia, Russia, India, Australia, made at the Ordnance Survey Office, Southampton." By Captain A. R. Clarke, R.E., F.R.S., &c., under the Direction of Colonel Sir Henry James, R.E., F.R.S., &c., Director of the Ordnance Survey. Received November 15, 1866.

(Abstract.)

In the preface to this paper, Sir Henry James gives an account of the circumstances under which the work was undertaken, as follows. (A Table of results is appended, p. 313.)

The principal triangulation of the United Kingdom was finished in 1851; and the triangulations of France, Belgium, Prussia, and Russia were so far advanced in 1860, that, if connected, we should have a continuous triangulation from the Island of Valentia on the south-west extremity of Ireland, in north latitude 51° 55′ 20″, and longitude 10° 20′ 40″ west of Greenwich, to Orsk on the River Ural in Russia.

It was therefore possible to measure the length of an arc of parallel in latitude 52° of about 75°, and to determine, by the assistance of the electric telegraph, the exact difference of longitude between the extremities of this arc, and thus obtain a crucial test of the accuracy of the figure and dimensions of the earth, as derived from the measurement of arcs of meridian, or the data for modifying the results previously arrived at.

The Russian Government, therefore, at the instance of M. Otto Struve, Imperial Astronomer of Russia, invited (in 1860) the cooperation of the Governments of Prussia, Belgium, France, and England, to effect this most important object, and to their great honour they all consented, and granted the necessary funds for the execution of the work.

The portion of the work which was assigned to me, was the connexion of the triangulation of England with that of France and Belgium, and I published the results of this operation in 1862*. But this work has been done in duplicate; for when application was made to the French Government to permit the necessary observations to be made in France, they not only consented to allow this, but at the same time volunteered to join in the labour and expense of the work itself.

It would obviously have been wrong to mix up observations made with different kinds of instruments and on different principles, and therefore it was agreed that the work should, in fact, be made in duplicate, both the French and English geometricians using exactly the same stations.

The results obtained by the French geometricians is published in the

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* Extension of the Triangulation of the Ordnance Survey into France and Belgium. London, 1863.

Supplement to vol. ix. of the 'Mémorial du Dépôt Général de la Guerre,' 1865, and the agreement with the results obtained by the English is truly surprising.

But however accurately the trigonometrical observations might be performed, it is obvious that, without a knowledge of the exact relative lengths of the standards used as the units of measure in the triangulation of the several countries, it would be impossible accurately to express the length of the arc of parallel in terms of any one of the standards.

It was therefore necessary that a comparison of the standards of length should be made, and as we had a building and apparatus expressly erected for the purpose of comparing standards at this Office, the English Government, on my recommendation, invited the Governments of the several countries named to send their standards here, and we have had the following compared with the greatest accuracy:—

1. Russian standard, double toise, P.
2. Prussian standard toise.
3. Belgium standard toise.
4. Platinum metre of the Royal Society, compared with the standard metre of France by M. Arago.
5. English standard yards, A, B, C, 29, 47, 51, 55, 58.
6. Ordnance Survey 10-foot standard bar.
7. Indian 10-foot standard bars, new and old.
8. Australian 10-foot standard bar.
9. In addition to the above, the 10-foot standard bar of the Cape of Good Hope was compared here in 1844.

We have invited the Governments of Austria, Spain, and the United States of America, also to send their standards. We have been promised that of Austria, and, but for the unfortunate war in which she has been lately engaged, we should have received it before this.

I have entrusted the execution of the work of comparison and the drawing up of the results to Captain Alexander R. Clarke of the Royal Engineers, who designed the apparatus used. The numerous comparisons to be made entailed a great amount of labour upon him and his assistants, Quartermaster Steel and Corporal Compton, of the Royal Engineers.

Before the connexion of the triangulation of the several countries into one great network of triangles, extending across the entire breadth of Europe, and before the discovery of the electric telegraph and its extension from Valentia to the Ural Mountains, it was not possible to execute so vast an undertaking as that which is now in progress. It is, in fact, a work which could not possibly have been executed at any earlier period in the history of the world. The exact determination of the figure and dimensions of the earth has been the great aim of astronomers for upwards of two thousand years, and it is fortunate that we live in a time when men are so enlightened as to combine their labours to effect an ob-

| Measures. | Expressed in Terms of the Standard Yard. 𝔜. | Expressed in inches. Inch=$\frac{1}{36}$ 𝔜. | Expressed in lines of the Toise. Line=$\frac{1}{864}$ 𝔗. | Expressed in Millimetres. Millimetre=$\frac{1}{1000}$ 𝔐. |
|---|---|---|---|---|
| The Yard................................................... | 1·00000000 | 36·000000 | 405·34622 | 914·39180 |
| Copy No. 55 of the Yard at its Standard Temperature of 62°·00 F. ............. | 0·99999960 | 35·999986 | 405·34606 | 914·39143 |
| Ordnance Standard Foot ,, ,, ,, 62·00 ............. | 0·33333284 | 11·999982 | 135·11521 | 304·79681 |
| Indian Standard Foot ,, , ,, 62·00 ............. | 0·33333611 | 12·000100 | 135·11653 | 304·79980 |
| Ordnance 10-foot Bar $O_1$ ., ,, ,, 62·00 ............. | 3·33333717 | 120·000138 | 1351·15563 | 3047·97616 |
| Ordnance 10-foot Bar $OI_1$ ,, ,, ,, 62·00 ............. | 3·33335432 | 120·000755 | 1351·16259 | 3047·99184 |
| Indian 10-foot Bar $I_S$ ,, ,, ,, 62·00 ............. | 3·33340138 | 120·002450 | 1351·18166 | 3048·03488 |
| Indian 10-foot Bar $I_B$ ,, ,, ,, 62·00 ............. | 3·33353284 | 120·007182 | 1351·23495 | 3048·15508 |
| Indian 10-foot Bar $I_b$ ,, ,, ,, 62·00 ............. | 3·33331457 | 119·999324 | 1351·14647 | 3047·95550 |
| Australian Standard $O_4$ ,, ,, ,, 62·00 ............. | 3·33330427 | 119·998954 | 1351·14230 | 3047·94608 |
| Australian Standard OI ,, ,, ,, 62·00 ............. | 3·33333747 | 120·000149 | 1351·15576 | 3047·97644 |
| Ordnance Toise ,, ,, ,, 61·25 ............. | 2·13166458 | 76·739925 | 864·06219 | 1949·17660 |
| Ordnance Metre ,, ,, ,, 61·25 ............. | 1·09374800 | 39·374928 | 443·34662 | 1000·11420 |
| Royal Society's Metre à traits ,, ,, ,, 32·00 ............. | 1·09360478 | 39·369772 | 443·28857 | 999·98324 |
| Prussian Toise No. 10 ,, ,, ,, 61·25 ............. | 2·13150911 | 76·734328 | 863·99917 | 1949·03444 |
| Belgian Toise No. 11 ,, ,, ,, 61·25 ............. | 2·13150851 | 76·734306 | 863·99893 | 1949·03390 |
| Russian Double Toise P ,, ,, ,, 61·25 ............. | 4·26300798 | 153·468287 | 1727·99419 | 3898·05952 |
| The Toise................................................... | 2·13151116 | 76·734402 | 864·00000 | 1949·03632 |
| The Metre ................................................... | 1·09362311 | 39·370432 | 443·29600 | 1000·00000 |

ject desired by all, and at the first moment when it was possible to execute it.

A full detailed account of the 'Comparisons of the Standards of Length,' with numerous plates, has just been published, and may be obtained from the agents for the sale of the publications of the Ordnance Survey.

## *December* 20, 1866.

Dr. WILLIAM ALLEN MILLER, Treasurer and Vice-President, in the Chair.

The following communications were read:—

## I. "On the Formation of 'Cells' in Animal Bodies." By E. Montgomery, M.D. Communicated by J. Simon, Esq.

Received November 8, 1866.

### (Abstract.)

### I.—*Observations.*

So called organic "cells," chiefly those of various cancerous tumours, were seen, on the addition of water, to expand to several times their original size, and at last to vanish altogether into the surrounding medium.

The "nucleus" did not always participate in this change, but at times remained unaltered, whilst the outer constituents of the "cell" were undergoing this process of expansion.

This curious phenomenon of extreme dilatation is intelligible only on the supposition that the spherical bodies in question are in reality globules of a uniformly viscid material, which by imbibition swells out till at last its viscosity is overcome by the increasing liquefaction.

In embryonic tissues and in various tumours, single "nuclei" were seen, each surrounded by a shred of granular matter. On the addition of water there would bulge from one of the margins of the granular mass a segment of a clear globule, which continued growing until it had become a full sphere, which ultimately detached itself, and was carried away by the currents. At other times no such separate globule would be emitted, but the entire granular shred would itself gradually assume the spherical shape, ultimately encompassing the "nucleus," and constituting with the same the most perfect typical "cell."

Not only single "nuclei" were found, each surrounded by a shred, but also clusters of two, four, and more were seen similarly enclosed by a proportionately large granular mass. Under these circumstances it sometimes occurred that, on the addition of water, the whole granular